

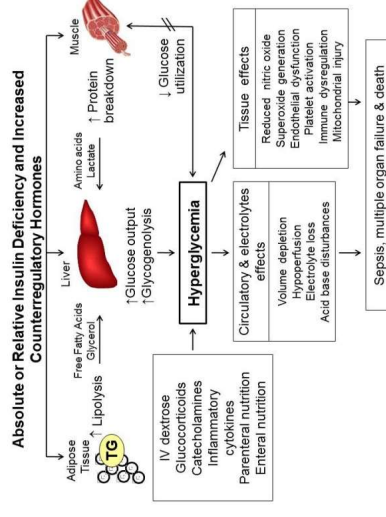
Perioperative Evaluation and Management of Diabetes

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No Financial
Disclosures/Relationships

1. Recognize the importance of perioperative glycemic control for patients with diabetes to optimize postsurgical outcomes
2. Identify perioperative adjustments of diabetes medications

Objectives



Pathogenesis of Hyperglycemia

- Hyperglycemia**
 - Poor glucose control prior to surgery
 - IV dextrose in periop period
 - Glucocorticoids administered in periop period
 - Stress of surgery and anesthesia alters and promotes hepatic glucose production and use of glucose in tissues
- Leads to—**
 - Volume depletion
 - Hypoperfusion
 - Electrolyte loss
 - Acid base disturbances
 - Immune dysfunction

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Results in...

Impaired insulin action

Insulin resistance

Post op day 1 up to 21 days²

Periop Hyperglycemia influenced by...

Location of surgery

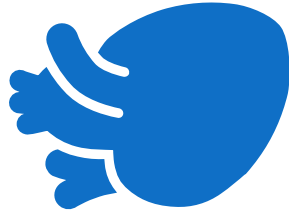
- Thorax and abdomen linked to greater and longer duration of hyperglycemia

Type of anesthesia

- General anesthesia linked with hyperglycemia²

Prevalence of Periop Hyperglycemia

- General surgery 20-40%
- Cardiac surgery 80%
- No known history of diabetes before surgery 12-30%²



Surgical Complications

Uncontrolled diabetes

- Retrospective study of 10.5 million patients reported increased risk of major adverse cardiovascular or cerebrovascular events after major noncardiac surgeries

Patients with diabetes have increased risk of—

- Respiratory infections
- Surgical site infections
- Delayed wound healing
- Urinary tract infections
- Acute kidney injuries
- Intensive care admissions
- Hospital length of stay³

Periop Glucose Goal

Periop blood glucose goal is less 180-200 mg/dL^{2,4}

Perioperative glucose levels correlate with surgical complication rates more than preoperative A1c

Hold surgery for diabetic ketoacidosis, hyperglycemia hyperosmolar state or glucose level greater than 300 mg/dL³

Preop Assessment³

Diabetes Diagnosis

- ▶ Type 1
- ▶ Type 2
- ▶ Diabetes in pregnancy

Details

- ▶ Type 1 diagnosis requires insulin
 - basal insulin needed when NPO
- ▶ Type 2 diagnosis treated with oral diabetes agents, insulin and/or non-insulin agents (GLP-1 RA)
- ▶ Diabetes in pregnancy
 - Tight glucose control during pregnancy
 - May be on insulin

Preop Assessment³

Glycemic Control

- ▶ Level of glycemic control
 - Glucose trends
 - HbA1c
 - Time in Range (TIR)
- ▶ Glucose monitoring
 - ▶ Fingertick glucose meter
 - ▶ Continuous glucose monitor (CGM)

Details

- ▶ Persistent hyperglycemia
 - Glucoses 200 or more
 - A1c greater than 8.0
- ▶ Hypoglycemia occurrence
 - Glucoses less than 70
 - Prone to hypoglycemia
- ▶ Is patient glucose monitoring?
 - Able to monitor

Diabetes Medication

- ▶ Type, dose and specific timing of—
 - Oral diabetes medication
 - Insulin
 - Noninsulin injectables
 - Inhalable insulin

Details

- ▶ Follow guidelines to adjust medication dosing in preop period

Preop Assessment³

Surgery	Details
▲ Surgery risk ▲ Low ▲ Intermediate ▲ High ▲ Duration ▲ Scheduled time ▲ When patient strict NPO	▲ Risk and duration of surgery determines glucose management during and post procedure ▲ Timing of surgery determines how diabetes medication is adjusted preop ▲ When NPO time starts determines how diabetes medication is adjusted preop ▲ Provide guidance on treatment of hypoglycemia

Glucose Management Before Surgery^{5,6}

Patient NOT IN HOSPITAL	Patient IN HOSPITAL
▲ Monitor ■ Morning ■ Every 2-4 hours until surgery ▲ Correct hyperglycemia ■ If on insulin ▲ Hypoglycemia ■ Treat if glucose less than 100 ▲ Arrival to surgery ■ Glucose obtained within 60 min	▲ Monitor ■ Morning ■ Every 2-4 hours until surgery ▲ Correct hyperglycemia ■ Per insulin orders ▲ Hypoglycemia ■ Treat per protocol ▲ Arrival to preop area ■ Glucose obtained within 60 min

Diabetes Medications NOT INSULIN

Oral Diabetes Medications

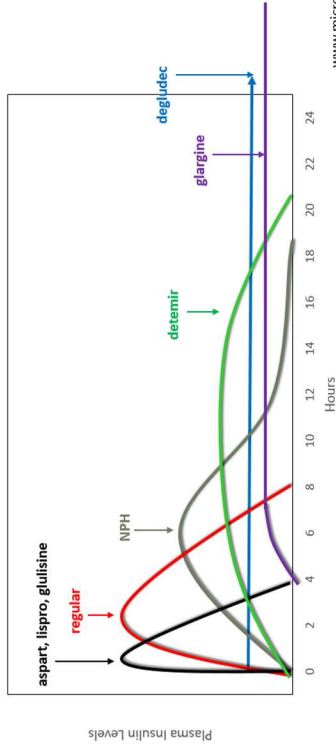
Class/Action	Generic Names	Considerations
Biguanides ↓ Hepatic glucose production ↓ GI absorption of glucose ↑ Insulin sensitivity of cells	• metformin • metformin XR	HOLD 48 hrs post dye study
Sulfonylureas ↑ Insulin secretion	• glyburide • glipizide • glimepiride	Risk of hypoglycemia
DPP-4 Inhibitors ↑ Insulin secretion with food ■ Slows gastric emptying	• sitagliptin • saxagliptin • linagliptin • alogliptin	
TZDs ↑ Insulin sensitivity	• pioglitazone • rosiglitazone	
SGLT2 INHIBITORS ↑ Glucose reabsorption by kidneys	• canagliflozin • dapagliflozin • empagliflozin • ertugliflozin	Not just prescribed for diabetes

Non-insulin Injectable Medications

Class/Action	Generic Names	Considerations
GLP-1 RECEPTOR AGONISTS 1 Insulin release with food - Slows gastric emptying - Promotes satiety - Suppresses glucagon	- exenatide - exenatide XR - dulaglutide - liraglutide - lixisenatide - semaglutide (injectable and oral)	Some are dosed weekly
GIP AND GLP-1 RECEPTOR AGONIST 1 Insulin release with food - Slows gastric emptying - Promotes satiety - Suppresses glucagon	tirzepatide	Dosed weekly

<https://www.micromedexsolutions.com>

Insulin Profiles



www.micromedexsolutions.com
Graphic: Faith Pollock

Insulin

Basal Insulins

Insulin Name	Onset	Peak	Duration	Frequency
glargine • Lantus • Toujeo • Basaglar • Semglee • Rezvoglar	2-4 hrs	none	20-24 hrs	1-2 times daily
detemir (Levemir)*	3-4 hrs	6-8 hrs	7-24 hrs	1-2 times daily
degludec (Tresiba)*	- 1 hr	none	42 hrs	Anytime daily, at least 8 hours apart
Humulin N* Novolin N	2-4 hrs	4-12 hrs	10-18 hrs	1-2 times daily

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Prandial and Correction Insulins

Insulin Name	Onset	Peak	Duration	Frequency
aspart (NovoLOG)*	5-15 min	40-50 min	3-5 hrs	Multiple times daily
Aspart (Fiasp)	2.5 min	40-60 min	3-5 hrs	
lispro (Humalog)	5-30 min	30-90 min	3-4 hrs	
Lispro-aabc (Lynumjev)	15 min	30-90 min	4.6-7.2 hrs	
lispro (Admelog)	5-30 min	30-90 min	3-4 hrs	
Humulin R* Novolin R	30-60 min	1.5-3.5 hrs	8 hrs	

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Mixed Insulins

Insulin Name	Onset	Peak	Duration	Frequency	Additional Info
Novolog Mix* 70/30	5-15 min	Dual peaks	10-18 hrs	1-2 times daily	Mixture of 70% NPH and 30% aspart
Humalog Mix 75/25	5-30 min		10-18 hrs		Mixture of 75% NPH and 25% lispro
Humalog Mix 50/50	5-30 min		10-18 hrs		Mixture of 50% NPH and 50% lispro
Novolin 70/30 Humulin 70/30	30-60 min		10/18 hrs		Mixture of 70% NPH and 30% regular

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U-500 Regular Insulin

- ▶ 5 times the concentration of U-100 Regular insulin
- ▶ Similar in action to NPH insulin
- ▶ Dosed 2 - 3 times per day
- ▶ Can last up to 24 hours

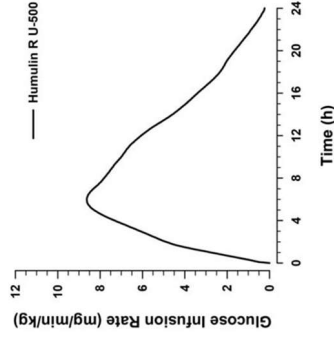


Figure 1: Mean Insulin Activity Versus Time Profiles After Subcutaneous Injection of a 100 U Dose of HUMULIN R U-500 in Healthy Obese Subjects

Diabetes Medication Management Before Surgery

Oral Diabetes Medication Management

Medication	Guidelines for Surgery		Notes
	DAY BEFORE	DAY OF	
Biguanides^{2,3,7} - metformin - metformin XR	TAKE OR HOLD EVENING DOSE	TAKE if normal oral intake anticipated same day and no contrast dye OR HOLD	Risk of lactic acidosis
Sulfonylureas^{2,3} - glyburide - glipizide - glimepiride	TAKE	HOLD	Risk of hypoglycemia
DPP-4 Inhibitors^{2,3} - sitagliptin - saxagliptin - linagliptin - alogliptin	TAKE	TAKE if normal oral intake anticipated same day OR HOLD	Low risk of hypoglycemia
TZDs^{2,3} - pioglitazone - rosiglitazone	TAKE	HOLD	Associated with increased intravascular volume

Oral Diabetes Medication Management

Medication	Guidelines for Surgery		Notes
	DAY BEFORE	DAY OF	
SGLT2 Inhibitors^{2,3} - bexagliflozin - canagliflozin - dapagliflozin - ertugliflozin - sotagliflozin (SGLT2 and SGLT1)	HOLD 3 days prior to procedure (4 days for ertugliflozin)		To avoid risk of ketoacidosis
GLP-1RA (Daily)⁸ semaglutide (oral)	HOLD seven (7) days prior to procedure requiring deep sedation or general anesthesia. Contact prescribing provider for glycemic management alternatives to avoid possible hyperglycemia before surgery.		Risk of hypoglycemia Slows gastric motility increasing risk of aspiration

Non-Insulin Injectable Management

Medication	Guidelines		Notes
	DAY BEFORE	DAY OF	
GLP-1 RA (Daily)⁸ - exenatide - liraglutide - lixisenatide with glargine - liraglutide with degludec	HOLD	HOLD Contact prescribing provider for insulin order due to basal insulin mix	Risk of hypoglycemia Slows gastric motility increasing risk of aspiration
GLP-1/GIP RA (Weekly)⁸ - albiglutide - dulaglutide - exenatide ER - semaglutide - tirzepatide (GLP-1 /GIP-RA)	HOLD seven (7) days prior to procedure requiring deep sedation or general anesthesia. Contact prescribing provider for glycemic management alternatives to avoid possible hyperglycemia before surgery.		Risk of hypoglycemia Slows gastric motility increasing risk of aspiration

Insulin Management

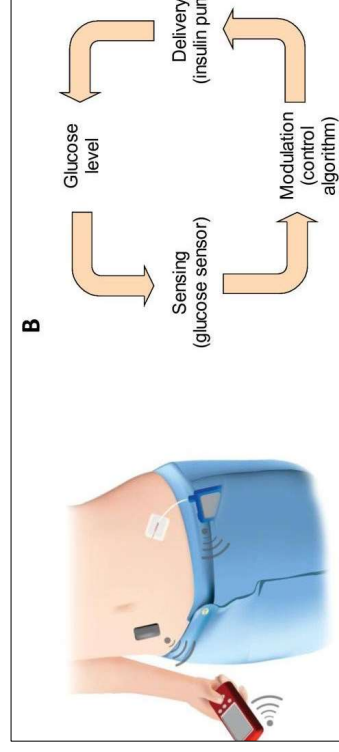
Medication	Guidelines for Surgery		Notes
	DAY BEFORE	DAY OF	
Rapid and Short Acting^{2,3} - aspart - lispro (U-100, U200) - glulisine - regular	TAKE usual doses	• HOLD mealtime dose • If using correction scale insulin, dose per to scale for hyperglycemia	Risk of hypoglycemia
Long Acting (Basal)^{2,3} - glargine (U-100, U300) - degludec (U-100, U200)	AM Usual dose PM Type 1 DM Usual dose OR 50% dose if prone to HYPOglycemia (malnourished, renal, hepatic impairment)	Type 1 DM Usual dose OR 50% dose if prone to HYPOglycemia (malnourished, renal, hepatic impairment)	Type 1 DM must take a dose of basal insulin when NPO to prevent ketoacidosis
		Type 2 DM 75-80% dose OR 50% dose if concerns for HYPOglycemia (60%+ of TDD*)	

Insulin Management

Medication	Guidelines for Surgery			Notes
	DAY BEFORE	PM	DAY OF	
Intermediate Acting^{2,3} - NPH - Mixed 70/30 (fixed combination of NPH and rapid or short-acting insulin)	AM - Usual dose - OR 80% dose	Type 1 DM - Usual dose OR 70-80% dose if prone to HYPOglycemia (malnourished, renal, hepatic impairment)	Type 1 DM 50% dose OR - HOLD if glucose less than 120 mg/dL	Type 1 DM must take a dose of basal insulin when NPO to prevent ketoacidosis
		Type 2 DM - Usual dose OR 70-80% dose if prone to HYPOglycemia (malnourished, renal, hepatic impairment)	Type 2 DM 50% dose - HOLD if glucose less than 120 mg/dL	
Concentrated R-U500	Contact prescribing provider for orders			High risk of hypoglycemia

Insulin Pump Management

Medication	Guidelines for Surgery		Notes
	DAY BEFORE	DAY OF	
Insulin pump with U-100 or U-200 insulin³	Manual basal rates Usual doses	Manual basal rates - Usual doses OR - Reduced dosing based on clinical history	Instruct patient to bring extra pump supplies Do not place infusion site in operative area
	Automatic Insulin Delivery Usual doses	Automatic Insulin Delivery Usual doses	
Insulin pump with U-500 insulin	Contact prescribing provider for orders		



Automated Insulin Delivery

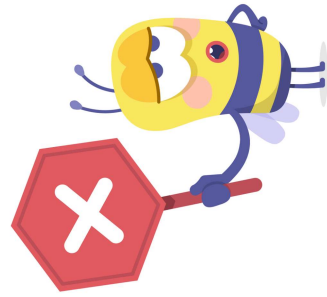
Automatically adjusts insulin doses to control glucose levels

- Stops and/or reduces insulin infusion to prevent HYPOglycemia
- Administers insulin doses to correct HYPERglycemia

INTRAOP Glucose Management

Blood Glucose Monitoring

At LEAST every 2 hours during surgery and continue into PACU²



Insulin IV Bolus



Achieving Glucose Control²

Insulin subcutaneously

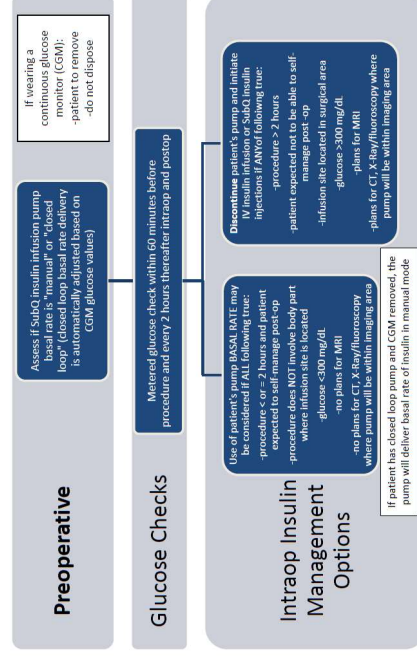
- Use rapid-acting like aspart, lispro
- For ambulatory or short duration surgeries (<4 hours)

Insulin infusion

- Adjust rates every 1 hour
- "REALTIME" insulin dosing
- For long surgeries (>4 hours)
- If expect hemodynamic changes, fluid shifts, or temperature changes

Insulin pump

AllinaHealth[®] Surgery Algorithm for Care of Patients with Continuous Subcutaneous (SubQ) Insulin Infusion (CSII)



In PACU

Continue glucose checks every 2 hours

Glucose goal continues to be less 180-200 mg/dL

Administer insulin as ordered

- Subcutaneous
- Insulin infusion

Patients on insulin pumps

- Anesthesia for more than 2 hours?
- Going to critical care unit?
- Steroids?
- Slow to awaken post surgery?

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